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Research Article

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Using the First-Order Perturbation Theory from Quantum Mechanics to Predict a Single Day of Postprandial Plasma Glucose Data and Waveform Using A Synthesized Glucose Data and Waveform from 181-Days Intermittent Fasting Period Based on GH-Method: Math-Physical Medicine (No. 471)

Gerald C Hsu

EclaireMD Foundation, USA

*Corresponding author
Gerald C Hsu, EclaireMD Foundation, USA

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Abstract

The author has applied the first-order interpolation perturbation equation from quantum mechanics in his medical research work, which he has written numerous articles on this topic. This equation is the simplest application using one selected "perturbation factor" to generate perturbed results with high prediction accuracy.

He investigates this type of problem using a chosen perturbation factor such as carbs/sugar for postprandial plasma glucose (PPG), body weight for fasting plasma glucose (FPG), or metabolism index (MI) in predicting a stroke or heart attack along with achieving longevity in the geriatric research area.

In this particular article, he uses one perturbation factor of an extremely low carbs/sugar amount (0.018 grams) which is extremely close to a total fasting situation.

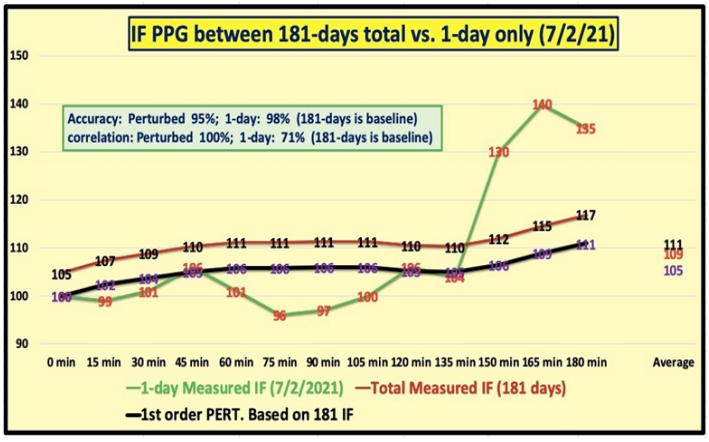
This comparison study also contains the following two final measurement yardsticks to provide confirmation of using the perturbed method. The first yardstick is to verify the prediction accuracies of the perturbed PPG value via their average PPG value of dataset or waveform. The second yardstick is to examine the waveform shape similarity via the calculated correlation coefficient between the measured PPG dataset and the perturbed PPG dataset.

In conclusion, the purpose of this study is to investigate the prediction accuracy and waveform shape similarities of a perturbed PPG waveform from his synthesized PPG waveform over 181 days of intermittent fasting (IF) period in comparison against one single fasting day during breakfast on 7/2/2021. He utilizes the first-order of perturbation equations with one selected perturbation factor of 0.9 grams, which is an "almost-fasting" carbs/sugar amount (0.018 grams), between the high-end (0.02 grams) and low-end (0.0 gram) of his baseline single IF breakfast.

The two conclusions drawn from this research work are listed below.

First, the perturbation equation offers an extremely high prediction accuracies, 97%.

Second, the perturbation equation also provides reasonably high predicted PPG waveform shape similarity with 71% of correlation coefficient between the measured and perturbed waveforms from a single day of IF during breakfast.



Introduction

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Methods

The author has chosen not to repeat all of the details regarding his applied methods as described in other papers. Instead, he outlines a few important equations, formulas, or conditions in this article.

MPM Background

To learn more about his developed GH-Method: math-physical medicine (MPM) methodology, readers can read the following three papers selected from the published 400+ medical papers.

The first paper, No. 386 (Reference 1) describes his MPM methodology in a general conceptual format. The second paper, No. 387 (Reference 2) outlines the history of his personalized diabetes research, various application tools, and the differences between biochemical medicine (BCM) approach versus the MPM approach. The third paper, No. 397 (Reference 3) depicts a general flow diagram containing ~10 key MPM research methods and different tools.

The Author'S Case of Diabetes

The author has been a severe type 2 diabetes patient since 1996. He weighed 220 lb. (100 kg, BMI 32.5) at that time. By 2010, he still weighed 198 lb. (BMI 29.2) with an average daily glucose of 250 mg/dL (HbA1C of 10%). During that year, his triglycerides reached to 1161 and albumin-creatinine ratio (ACR) at 116. He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding his needs of kidney dialysis treatment and his future high risk of dying from his severe diabetic complications.

In 2010, he decided to self-study endocrinology, diabetes, and food nutrition. During 2015 and 2016, he developed four prediction models related to diabetes conditions, i.e., weight, PPG, fasting plasma glucose (FPG), and HbA1C (A1C). As a result, from using his developed mathematical metabolism index (MI) model and those four prediction tools, by end of 2016, his weight was reduced from 220 lbs. (100 kg, BMI 32.5) to 176 lbs. (89 kg, BMI 26), waistline from 44 inches (112 cm) to 33 inches (84 cm), averaged finger glucose from 250 mg/dL to 120 mg/dL, and HbA1C from 10% to ~6.5%. One of his major accomplishments is that he no longer takes any diabetes medications since 12/8/2015.

In 2017, he had achieved excellent results on all fronts, especially glucose control. However, during the pre-COVID period of 2018 and 2019, he traveled to approximately 50+ international cities to attend 65+ medical conferences and made ~120 oral presentations. This hectic schedule inflicted damage to his diabetes control, through dinning out frequently, post-meal exercise disruption, jet lag, and along with the overall metabolism impact due to his irregular life patterns through a busy travel schedule; therefore, his glucose control was affected during this two-year period.

By year end of 2020, his weight was further reduced to 165 lbs. (BMI 24.4) and his HbA1C was at 6.2% without any medications intervention or insulin injection. Actually, during 2020 with the special COVID-19 quarantined lifestyle, not only has he published approximately 400 medical papers in journals, but he has also achieved his best health conditions for the past 26 years. These good results are due to his non-traveling, low-stress, and regular daily life routines. Of course, his knowledge of chronic diseases, practical lifestyle management experiences, and his developed various high-tech tools contribute to his excellent health status since 1/19/2020.

On 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and checks his glucose measurements every 5 minutes for a total of ~288 times each day. He has maintained the same measurement pattern to present day. In this study, he uses his CGM sensor glucose at time-interval of 15 minutes (96 data per day).

Therefore, during the past 11 years, he could study and analyze his collected 2 million data regarding his health status, medical conditions, and lifestyle details. He applies his knowledge, models, and tools from mathematics, physics, engineering, and computer science to conduct his medical research work. His medical research work is based on the aims of achieving both "high precision" with "quantitative proof" in his medical findings.

Intermittent Fasting

The following section covers the health effects of IF with an excerpt from external publications in the section of References:

"Intermittent fasting (IF) refers to fasts lasting from 12 to 48 hours that are repeated every 1 to 7 days, whereas periodic fasting (PF) lasts between 2 and 7 days and is repeated at least once per month.

Furthermore, there are two types of PF. The first is water-only and the second is a fast-mimicking diet (FMD), which refers to consuming only a plant-based, calorie-restricted diet that consists of low proteins, low sugars, and high unsaturated fats.

According to an article published in Nature Aging, IF and PF/FMD trigger pathways that activate alternative metabolic modes that focus on "conserving energy and on protecting the organism while

enduring extended periods of food deprivation to optimize survival and reproduction once food becomes available." Intriguingly, the refeeding period plays an equally important part in regeneration, as well as rejuvenation of organs, cells, and organelles.

"In humans, the alternation of fasting and refeeding periods is accompanied by positive effects on risk factors for aging, diabetes, autoimmunity, cardiovascular disease, neurodegeneration and cancer," the authors wrote. "But not all fasting interventions are equal, and some are associated with smaller beneficial effects as well as side effects, including, in some cases, reduced longevity.

Health Effects of Intermittent Fasting

The Nature Aging authors cited studies that showed IF resulted in weight loss, as well as positive effects on metabolic markers and decreased insulin resistance. IF was correlated with decreased levels of low-density lipoprotein (LDL); the metabolic regulator triiodothyronine; and soluble intracellular adhesion molecule-1 (sICAM-1), an age-associated inflammatory marker.

Other studies demonstrated that IF led to a reduction in weight gain, better sleep, decreased deterioration in cardiac performance caused by age and diet, decreased oxidative stress, and better blood pressure levels. Along the same lines, in a review published in Clinical Diabetes and Endocrinology, the authors found evidence that IF helps improve diabetes and decreases body weight; lowers fasting glucose, fasting insulin, levels of leptin, insulin resistance; and increases adiponectin levels. Because IF is effective at attenuating the harms of type 2 diabetes, it makes sense that it could be a useful dietary intervention. ***Although the authors recommend this therapy, they urge caution."***

Unfortunately, the findings from this particular single case with limited patient data do not completely conform with the conclusions in References. The resulted analysis data in this article shows some insignificant and lower impacts from IF on reduction of his body weight or his glucoses.

Perturbation Theory of Quantum Mechanics or Modern Physics

The author applies the first-order interpolation perturbation method to obtain his "perturbed PPG" waveforms based on one selected carbs/sugar intake amount functioning as the ***perturbation factors,*** which is the ***"Slope".*** He uses the "measured PPG" waveform as his reference or baseline waveform.

The following polynomial function is used as the perturbation equation:

$$A = f(x) = A0 + (A1*x) + (A2*x**2)+(A3*x**3) + ... + (An*x**n)$$

Where A is the perturbed glucose, Ai is the measured glucose, and ***x is the perturbation factor*** based on a chosen carbs/sugar intake amount.

For this particular study, he choose his ***Ai as A1, where i=1***. In this way, the above equation can then be simplified into the first-order perturbation equation as follows:

$$A = f(x) = A0 + (A1*x)$$

Or the first-order interpolation perturbation equation can also be expressed in the following general format:

$$A\,i = A1 + (A2-A1)*(slope\ 1)$$

Where:
A1 = original glucose A at time 1
A2 = advanced glucose A at time 2
(A2-A1) = (Glucose A at Time 2 - Glucose A at Time 1)

The perturbation factor or ***Slope*** is an arbitrarily selected parameter that controls the size of the perturbation. The author has chosen a function of carbs/sugar intake amount, as his perturbation factor or slope, which is further defined below:

In this particular study, he selects the 0.0 gram as the low-bound carbs/sugar amount and 0.02 grams as the high-bound carbs/sugar amount, while uses 0.018 grams as his selected or perturbed carbs/sugar amount.

Then the "slope" becomes:

$$Slope = (Selected\ Carbs - Low\text{-}bound\ Carbs) / (High\text{-}bound\ Carbs - Low\text{-}bound\ Carbs)$$

It should be noted that, for achieving a better predicted glucose value, the selected carbs amount should be within the range of the high-bound carbs and the low-bound carbs, where these two boundary carbs amounts should be wide enough in magnitude to include the perturbed value in between.

Therefore, in this particular study, his slope or perturbation factor value has been calculated as:

Slope from Carbs = 0.9 or 90%

Results

Figure 1 illustrates the glucose dataset of the total 181-days synthesized IF glucose, which is used as the baseline reference waveform in calculating the perturbed 3-hour IF glucose dataset. Then, it compares against the measured 3-hour IF glucose values on 7/2/2021. It also contains the step-by-step calculation to obtain the first-order perturbation factor of 0.9 or 90%.

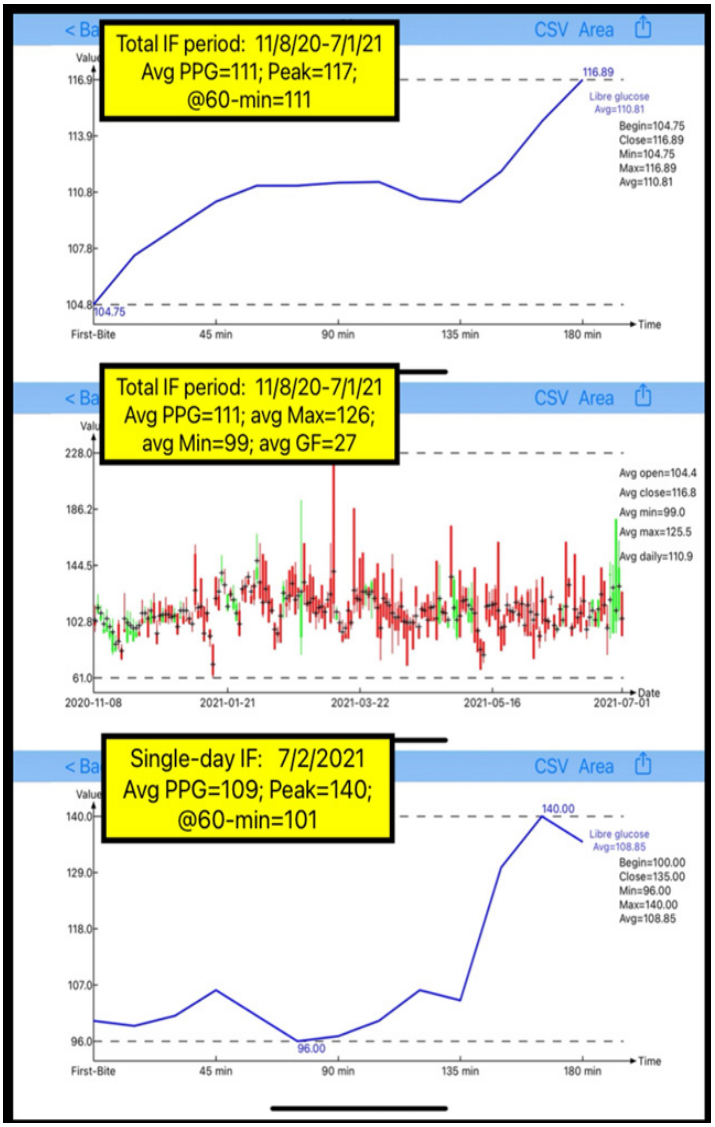

Figure 1: Glucose & body weight data of 181 IF days from 11/8/2018 to 7/1/2021

During the period from 11/8/2020 to 7/1/2021, the lower diagram in Figure 1 depicts the existing high correlation coefficient of 81% between weight in the morning (average of 168 lbs.) and measured FPG in early morning (average of 95 mg/dL, which provides a ratio of 57% (95/168). Furthermore, the average IF PPG at 0-minute is 105 mg/dL which is 10 mg/dL higher than the average FPG of 95 mg/dL.

Following this simsimple arithmetic concept, we can then calculate the IF/PPG at 0-minute on 7/2/2021 using the following formula:

IF/PPG at 0-minute
= Weight*(FPG/Weight)+10 mg/dL

For 181-days of IF period:
= 168*(57%) + 10
=105 mg/dL

For IF PPG on 7/2/2021:
= 170 * (54%) + 10
= 101 mg/dL

The two calculated IF/PPG values at 0-minute completely match with the actual measured data.

The above calculation has demonstrated the strong relationship among weight, FPG, and PPG at 0-minute.

Figure 2 shows the direct comparison between the total 181-days synthesized IF datasets with the IF/PPG dataset on 7/2/2021. The upper two diagrams reflect the ***synthesized 181-days IF/PPG*** waveform, and its associated candlestick k-line chart of 181 IF days during the time period from 11/8/2020 to 7/1/2021. The lower diagram reveals the single day ***IF/PPG*** waveform on 7/2/2021.

(11/8/20-7/1/21)	1-day Measured	Total Measured	1st order PERT.
PPG due to Carbs	IF (7/2/2021)	IF (181 days)	Based on 181 IF
0 min	100	105	100
15 min	99	107	102
30 min	101	109	104
45 min	106	110	105
60 min	101	111	106
75 min	96	111	106
90 min	97	111	106
105 min	100	111	106
120 min	106	110	105
135 min	104	110	105
150 min	130	112	106
165 min	140	115	109
180 min	135	117	111
Average	109	111	105
Accuracy (vs. COVID)			*97%*
Correlation			*71%*
Carbs & Walking	*High-carbs*	*Low-carbs*	*Selected*
Range of Carbs/Sugar	*0.02*	*0.0*	*0.018*
First-order Perturbator			*90%*

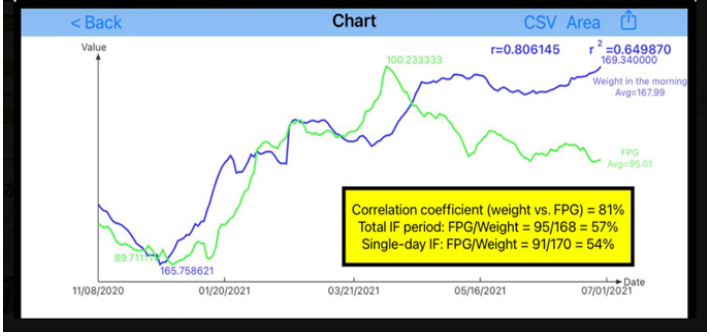

Figure 2: IF/PPG waveform, and candlestick k-line chart of 181 IF days with a single-day breakfast PPG waveform on 7/2/2021

Figure 3 demonstrates the comparison between the resulting perturbed PPG waveforms against two measured PPG waveforms of 181-days synthesized and a single day on 7/2/2021. The red curve is the measured IF/PPG dataset over 181 days, which is smoother due to the synthesized operation with an average glucose at 109 mg/dL. The black perturbed curve based on the synthesized 181-days IF/PPG measurements has an average value of 111 mg/dL. ***This perturbed PPG has a Prediction Accuracy of 96% and Correlation of 71% in comparison with the measured single day's IF/PPG curve on 7/2/2021.***

(11/8/20-7/1/21)	1-day Measured	Total Measured	1st order PERT.
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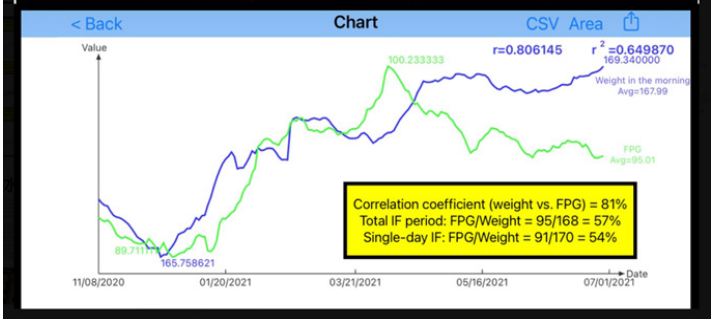

Figure 3: Single day's perturbed PPG waveform in comparison with measured PPG waveforms of 181 days and single IF day of 7/2/2021

Conclusions

In conclusion, the purpose of this study is to investigate the prediction accuracy and waveform shape similarities of a perturbed PPG waveform from his synthesized PPG waveform over 181 days of intermittent fasting (IF) period in comparison against one single fasting day during breakfast on 7/2/2021. He utilizes the first-order of perturbation equations with one selected perturbation factor of 0.9 grams, which is an "almost-fasting" carbs/sugar amount (0.018 grams), between the high-end (0.02 grams) and low-end (0.0 gram) of his baseline single IF breakfast.

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